CO_2 Budget Trading Program,

Part VII of 9VAC5-140

(Regulation for Emissions Trading).

Virginia Department of Environmental Quality

COMMENTS OF MALIN MOENCH ON THE CO_2 BUDGET TRADING PROGRAM PROPOSED UNDER EXECUTIVE DIRECTIVE 11

(April 9, 2018)

Background

This cap-and-trade proposal would cap emissions from Virginia's electricity sector beginning in 2020 and reduce them by 30 percent over a decade. Under the proposal, Virginia would join nine other states in the Regional Greenhouse Gas Initiative (RGGI). The plan is similar to President Obama's Clean Power Plan in its methods and intended greenhouse gas emission-reduction results.

Virginia's electric utilities have already been reducing their emissions. Coal's share of the state's electricity generation fell from 45 percent in 2005 to 20 percent in 2015, largely replaced by natural gas. Emissions did rise in 2016, however, to about 37.5 million tons, after holding steady for several years.

The proposed rule would cap carbon dioxide emissions at either 33 million tons or 34 million tons in 2020. The objective is to match existing emissions levels and corresponding emissions credits. Most provisions of the proposed rule track RGGI's model state cap-and-trade regulation. Virginia's utilities would collectively have to reduce emissions 3 percent per year through 2030, matching what RGGI states agreed to in August. Virginia utilities would be allowed to sell emissions allowances at auctions if they're able to cut their emissions cheaply, or, if not, they could buy allowances from others. The proposal would authorize a cost containment reserve consisting of 10 percent of the emission credit inventory, and an emissions containment reserve, consisting of another 10 percent of emissions credit inventory. Five percent of that inventory would be set aside, and allocated by Virginia's Department of Mines, Minerals and Energy to investors in energy efficiency projects and other demand reduction initiatives. These credits would also be auctioned by RGGI. The proceeds would be returned to the investors in these projects. Presumably, the investors in these projects would be allowed to keep the auction proceeds, which would reduce the cost of implementing their projects.

One feature of the proposal differs from the RGGI model plan. Rather than having utilities purchase their credits, Virginia's utilities would be given a set number of "conditional allowances" for free, based on their history of emissions. They must sell their conditional credits in an auction before buying back the number of allowances needed to cover their emissions. If a source cuts its emissions enough that it can sell more credits than it buys, the revenue goes to

the utility. It isn't clear whether the State Corporation Commission can or will order the utility to return all of the proceeds to directly to its customers or order the utility to invest some of it to improve the efficiency of its operations, end-user efficiency programs, or renewable energy projects. Given the SCC's history, it seems likely that it will order all of it to be refunded directly to customers.

If Virginia does join RGGI, it would be the biggest emitter in the carbon market. The addition would boost RGGI's 2020 cap—currently set at about 78 million tons—by more than 40 percent. RGGI has been largely succeeded in cutting emissions without driving up costs. An analysis by the Acadia Center, a climate advocacy and research group, found that emissions from power plants in RGGI states fell to 79 million tons in 2016, a drop of nearly 5 percent from the previous year. Since 2008, before RGGI began, emissions have fallen 40 percent. Adding Virginia to the carbon-trading market would substantially increase the number and diversity of market participants. This should significantly increase the efficiency of that market, and lower energy production costs. This is all the more likely if New Jersey rejoins RGGI. This likely cost-lowering effect is a major reason for adopting the proposed rule.

My comments will argue that, according to recent research, the fracking industry leaks a substantially higher percentage of extracted methane into the atmosphere unburned than regulators have been assuming. As a consequence, as fracked gas becomes the dominant source of the natural gas consumed in Virginia, the impact of generating electric power from natural gas on the climate will approach, and could eventually surpass, that of coal, on a per-Btu basis. If the climate-warming propensity of fracked gas is not accurately reflected in the CO_2 conversion factors on which this program is based, the program will not accomplish its purpose of shifting electric power production to the least climate-disrupting source.

Summary

My comments discuss the relative harm that coal, natural gas, and forest residuals do to the climate, and to human health, when they are burned to generate electric power. Conventional wisdom is that coal is both the most climate forcing and the most harmful to public health, on a per-Btu basis. Virginia's proposed cap and trade program will incentivize a shift from coal to natural gas and forest residuals. The latest science suggests that such shifts would not benefit either the climate or public health. The recently-discovered intensity of the impact of fracked gas on the climate implies that Virginia's cap-and-trade program should treat coal, forest residuals, and natural gas, as having roughly equal climate impacts.[1] Therefore, the proposed cap-and-trade program should have incentives that are roughly equal to shift away from the burning of coal, natural gas, and forest residuals as sources of electric power toward energy efficiency programs and renewable power.

The takeaway from this is that the factors used to convert burned natural gas and burned forest residuals to CO_2 equivalents must reflect estimates in the most recent research if the cap-and-trade program is to achieve its objective of shifting power production toward the least climate-harming sources.

[1] Burning natural gas produces far fewer pollutants that harm public health than coal or forest residuals, but that is not the focus of the cap-and-trade program.

Also, the proposed cap-and-trade program should double incentives for energy efficiency programs and renewables that are truly clean in terms of the carbon and the toxins that they emit. The program's five-percent emission credit set aside for energy efficiency and demand reduction programs should be at least 10 percent. Obama's national clean power plan included doubled emission-rate credits for early-period energy efficiency program spending that avoids the need to produce power. The Virginia cap-and-trade program should have a comparable incentive.

The high Global Warming Potential (GWP) of fracked gas must be accounted for.

[[Obama's clean power plan provided for gas-shift emission rate credits for utilities that replace coal-fired production with gas turbine production. Virginia's plan should not include such credits. The proposed regulations cap CO_2 emissions by electricity producers. Electricity producers who find the restrictions binding, in other words, producers who would have emitted more than their allotted allowances without the restrictions, would either need to shift to less carbon-intense methods of producing electricity or purchase additional allowances. The alternative methods would presumably be more expensive, otherwise the restrictions would not have been binding. Firms in this position would encounter increased costs due to the proposed regulation.
http://townhall.virginia.gov/L/GetFile.cfm?File=C:%5CTownHall%5Cdocroot%5C1%5C4818%5C8130%5CEIA_DEQ_8130_v2.pdf.]]

Recent research shows that the life-cycle of natural gas production and consumption is as climate warming as the life-cycle of coal production and consumption. This is largely because fugitive methane is a far larger percentage of extracted gas than had been assumed as recently as the formulation of the Obama Administration's Clean Power Plan. That plan had included emission credits for shifting from coal to gas usage, on the assumption that burning natural gas was substantially less carbon-intense than burning coal. Fugitive methane was thought to be under 2% of conventionally extracted gas, and the fugitive methane problems was assumed to be no worse for fracked gas than conventional gas.

Based recent analyses of satellite data, about 3.8% of conventional natural gas production is fugitive methane, taking both upstream (drilling and storing) activity, and downstream (transportation and distribution) into account. The situation is different for upstream activity for shale gas. The high-volume hydraulic fracturing with high-precision directional drilling that is used to develop shale gas leads to an intensity of development not generally seen with conventional natural gas, and to the redevelopment of regions where conventional gas has largely played out. This intensifies some effects such as air emissions due to interactions with old wells and formations.[2] Consequently, about 12% of shale gas production is fugitive methane.[3]

[2] Caulton DR, Shepson PB, Santoro RL, et al. Toward a better understanding and quantification of methane emissions from shale gas development. Proc Nat Acad Sci U S A. 2014;111: 6237–6242.

The proposed cap-and-trade program is intended to take effect in 2020. Twenty years from then, at current rates of greenhouse gas emissions growth, several important climate tipping points may be crossed. These include the irreversible melting of Arctic permafrost and release of trapped methane, irreversible melting of the Greenland and Western Antarctic ice sheets, and ocean acidification sufficient to doom coral reefs and krill populations. This argues for analyzing climate impacts over a 20-year time frame when evaluating the costs of greenhouse gas emissions.

Over a 20-year time frame, methane is 87 times as efficient as CO_2 at retaining infrared heat reflected outward from the earth. Experts have calculated that over that time frame, generating electricity from natural gas (methane) would equal the global warming potential of generating it from existing thermal coal plants if 4.8% of the extracted methane were lost to the atmosphere. Generating electricity from natural gas would equal the global warming potential of generating electricity from newly-built, more efficient thermal coal plants if leaked methane is just 3% of the extracted resource.[4] Based on these calculations, at current estimates of rates of leaked methane, conventionally produced natural gas is as harmful to the climate as new, efficient thermal coal plants, and **fracked shale gas is four times as harmful to the climate as new, efficient thermal coal plants would be**.

This fact should raise alarm bells about properly measuring the Global Warming Potential of the natural gas that is expected to be burned in Virginia from 2020 to 2030. The two new pipelines that are now being constructed in Virginia are expected to carry mostly fracked gas. An accurate assessment of the fugitive methane generated by that gas is essential if the CO_2 equivalents used to measure contributions to the cap are to be valid. For reasons given above, 20-year global warming potential (20-year GWP) is the more appropriate measure to use in calculating conversion factors in the proposed cap-and-trade program. After properly accounting for fugitive methane, and using a 20-year impact analysis, it may very well be that shifts to natural gas should incur emission penalties, rather than emission credits.

Biomass should not be eligible for cap credits

Forest products are renewable over a sufficiently long time frame. In Virginia, hardwood forests predominate. It takes such forests from 70 to 100 years to mature after clear cut harvesting. Conventional wisdom is that burning forest-scrap biomass to generate electric power has the virtues of other renewables because the carbon emitted into the atmosphere now will over 70-100 years, be pulled back out of the atmosphere, assuming that all of the acreage

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[3] Howarth, R., Methane Emissions and Climatic Warming Risk from Hydraulic Fracturing And Shale Gas Development: Implications For Policy, *Energy And Emission Control Technologie*s, October 8, 2015, 45-54, at 48.

[4] Hausfather, Z., Climate Impacts of Coal and Natural Gas, Berkeley Earth, available at http://static.berkeleyearth.org/pdf/climate-impacts-of-coal-and-natural-gas.pdf.

from which the wood scrap came is returned to natural forest. The conventional wisdom further assumes forest residue that is not burned to produce grid electricity would otherwise be left to decompose on the forest floor, emitting CO_2 in the process.

The conventional analysis of the consequences of burning forest residue for electric power omits an examination of its unintended economic effects. An analysis of all relevant effects reveals that burning forest residue causes a net increase in atmospheric CO_2, both in the short and the long run.

The first effect that conventional analysis overlooks is that much of the forest residue burned to produce grid electricity would otherwise become feedstock for a wide array of forest products. According to a 2015 study by Resource Information Systems, Inc., the vast majority of wood matter burned for grid electricity is pulpwood and clean sawmill residuals (76% and12%, respectively). The report says that if not burned, this material would be used to produce products such as pulp, paper, packaging and wood panels. If this resource is burned to produce electric power, the resource consumed adds a roughly equivalent amount of demand for forest residue from other forests. Satisfying that demand from other forests leads to more total acres logged in the Southern United States. http://www.afandpa.org/media/news/2015/11/18/new-research-shows-uk-wood-pellet-subsidies-distort-the-us-market-for-wood-fiber. This reduces the forest acreage in the Southern United states that serves as a carbon sink.

The second effect that conventional analysis overlooks is that some of the forest residue burned to produce grid electricity would otherwise be burned in cogeneration facilities to power wood products manufacturing plants. According to the American Forest and Paper Association, wood products manufacturing facilities are often powered with manufacturing residuals. This process, it says, creates both thermal and electrical energy. Efficiencies above 60% are often achieved in cogeneration facilities, which is more than double the efficiencies achieved by burning forest residue to produce grid electricity. To the extent that burning forest residue for grid power displaces its use as fuel for cogeneration at a wood products plant, it shifts energy production from a less CO_2- intensive application to a more CO_2- intensive application. http://www.afandpa.org/docs/default-source/1pgrs/2017-june-update/biomass-and-renewable-energy-may-2017.pdf?sfvrsn=2.

As discussed above, the relevant time frame for analyzing climate harm from energy production is 20 years from the start of the proposed cap-and-trade program, due to the numerous tipping points that may crossed by 2040 under current rates of emissions growth. If burning Virginia's forest residue to generate electric power were climate neutral over a 70-100 time frame (setting aside the above analysis of indirect economic effects) burning wood scraps for power is not climate neutral over the more relevant 20-year frame. For these reasons, forest residue burned to generate electric power should not be eligible for renewable energy credits.

The following technical information is summarized in the article "Does replacing coal with wood lower CO_2 emissions? Dynamic lifecycle analysis of wood bioenergy**,"** John D Sterman, Lori Siegel and Juliette N Rooney-Varga, Published 18 January 2018, Published by IOP Publishing Ltd
Environmental Research Letters, Volume 13, Number 1
Focus on The Role of Forests and Soils in Meeting Climate Change Mitigation Goals. Per Btu, burning wood emits 10-35% more CO_2 than burning coal, depending on the moisture

content of the fuel, the combustion efficiency of the plant, and processing losses. Typical combustion efficiencies for wood are approximately 25%, compared to 35% for coal.[5] Typical energy content lost during processing in the wood pellet supply chain averages 27% if biomass is used in the drying process,[6] compared to losses of approximately 11% for coal.[7] Regrowth of clear-cut hardwood forests probably will not offset the higher CO_2 intensity of burning wood residuals until the year 2100. By then, under current CO_2 emission trends, the world will almost certainly have blown passed critical tipping points in the carbon cycle, such as the release of methane from melted permafrost and undersea clathrates.

Voicing similar concerns, 200 European ecologists sent a letter in 2017 to the European Union urging it not to classify electricity obtained by burning wood products as carbon neutral, counting toward renewable energy targets under the 2015 Paris Accords. Their letter said:

> Bioenergy is not carbon-neutral and can have seriously negative climate impacts. The combustion of forest biomass generally releases more carbon dioxide to the atmosphere than fossil fuels, because of the lower energy density and conversion efficiency of biomass (more has to be burnt relative to fossil fuels). The LULUCF regulation needs to account for the full climate impact of biomass. To effectively reduce emissions from combustion of forest biomass, use of feedstocks with long payback periods should be avoided.

https://drive.google.com/file/d/0B9HP_Rf4_eHtQUpyLVIzZE8zQWc/view.

Similarly, in the summer of 2017, the House Appropriations Committee passed a spending bill funding the EPA. The Committee included a rider ordering the EPA to define burning wood to generate electricity as "carbon neutral." In response, 65 research scientists and practitioners sent an open letter to the Senate asking it to drop the mandate. Their letter said while it was "well intentioned," it would make climate change much worse. https://www.cnbc.com/2017/09/15/biomass-and-climate-change-burning-wood-for-energy-in-21st-century.html.

Wood-fired power plants emit as many toxins as coal-fired plants

The Canadian government's official website, Healthy Canadians, states boldly and unequivocally, "Avoid Wood Smoke." https://www.canada.ca/en/health-canada/services/air-quality/indoor-air-contaminants/avoid-wood-smoke.html. There are good reasons for this official government warning. Wood-fired power plants and coal-fired power plants are primarily

[5] Netherlands Enterprise Agency 2011 CO2-tool electricity gas and heat from biomass—version 1.0.1 (Assen, The Netherlands) www.rvo.nl/file/1252, IEA 2016 *World Energy Outlook* (Paris: International Energy Agency) www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html

[6] Röder, M., Whittaker, C, and Thornley, P., 2015 How certain are greenhouse gas reductions from bioenergy? Life cycle assessment and uncertainty analysis of wood pellet-to-electricity supply chains from forest residues *Biomass Bioenergy* **79** 50–63.
IEA 2016 *World Energy Outlook* (Paris: International Energy Agency) www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html.

[7] IEA 2016 *World Energy Outlook* (Paris: International Energy Agency) www.iea.org/newsroom/news/2016/november/world-energy-outlook-2016.html.

neurotoxin and carcinogen factories from a physician's point of view, but on a Btu-equivalent basis, wood-fired is worse. The proposed cap-and-trade program should not make such plants eligible for carbon credits on that basis alone.

Burned biomass can exceed coal in its emission of toxins that harm to public health. It contains over 200 toxic chemicals, including carbon monoxide, formaldehyde, sulfur dioxide, nitrogen oxides, dioxins, polycyclic aromatic hydrocarbons (PAHS), furans, heavy metals, and particulate matter. The component of burned wood emissions that harms human health the most, because of its abundance, is fine particulate matter or PM2.5. PM2.5 consists mostly of microscopic dagger-shaped particles. When inhaled, they lodge in the lining of the lung and pass into bloodstream where they are distributed throughout the body. Wood smoke contains a much higher percentage of ultrafine soot particles than coal emissions.[8] Ultrafine soot more easily penetrates cell walls, mitochondria, and the cell nucleus.[9] This triggers systemic inflammation which, leads to respiratory disease, cardiovascular disease, diabetes, and Alzheimer's.

The components of wood smoke are similar to those of cigarette smoke. Both types of smoke include particulate matter, carbon monoxide, formaldehyde, sulfur dioxide, nitrogen oxides, dioxins, and polycyclic aromatic hydrocarbons (PAHs).[10] The very small size of the particulate emissions and high levels of PAHs from wood smoke may account for its excessive toxicity compared to fossil fuel-generated particulate matter. Ultrafine particles are more potent in inducing inflammatory responses in the human body than fine particles.[11] Wood smoke produces high levels of free radicals, leading to DNA damage as well as inflammatory and

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[8] Ries et al.. Intake Fraction of Urban Wood Smoke, Envir Sci Tech, 2009; Wood Smoke Brochure. Vol. 113, No. 4, April 2005 http:// www.burningissues.org; Environmental Impact of Residential Wood Combustion Emissions and Its Implications, John A. Cooper, APCA Journal, Vol.30 No.8, August 1980

[9] Geiser M, Rothen-Rutishauser B, Kapp N, Schürch S, Kreyling W, Schulz H, et al. 2005. Ultrafine Particles Cross Cellular Membranes by Nonphagocytic Mechanisms in Lungs and in Cultured Cells. Environ Health Perspect 113:1555-1560. doi:10.1289/ehp.8006.

[10] Minnesota Pollution Control Agency, http://www.pca.state.mn.us/air/woodsmoke/healtheffects.html.

[11] Unosson J, Blomberg A, Sandström T, Muala A, Boman C, Nyström R, Westerholm R, Mills NL, Newby DE, Langrish JP, Bosson JA. Exposure to wood smoke increases arterial stiffness and decreases heart rate variability in humans. Part Fibre Toxicol. 2013 Jun 6;10(1):20. [Epub ahead of print]; American Lung Association – Air Quality http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=23354; Brown DM, Stone V, Findlay P, MacNee W, Donaldson K: Increased inflammation and intracellular calcium caused by ultrafine carbon black is independent of transition metals or other soluble components. Occup Environ Med 2000, 57:685-691. Murphy SAM, Berube KA, Richards RJ: Bioreactivity of carbon black and diesel exhaust particles to primary Clara and type II epithelial cell cultures. Occup Environ Med 1999, 56:813-819; Höhr D, Steinfartz Y, Schins RPF, Knaapen AM, Martra G, Fubini B, Borm PJA: The surface area rather than the surface coating determines the acute inflammatory response after instillation of fine and ultrafine TiO2 in the rat. Int J Hyg Environ Health 2002, 205:239-244; Monteiller C, Tran L, MacNee W, Faux S, Jones A, Miller B, Donaldson K: The pro-inflammatory effects of low-toxicity low-solubility particles, nanoparticles and fine particles, on epithelial cells in vitro: the role of surface area. Occup Environ Med 2007, 64:609-615.

oxidative stress responses in gene expression in cultured human cells.[12] Exposure to PAHs has been associated with mutations in tumor suppressor genes.

Coal emissions and secondhand cigarette smoke cause gene mutations and cancer. The leading culprits are the Polycyclic Aromatic Hydrocarbons (PAH) and free radicals that they contain. There are more of these toxins in wood smoke than in coal emissions or secondhand cigarette smoke. Consequently, the risk of getting cancer from breathing wood smoke is twelve times higher than breathing the same volume of secondhand cigarette smoke. (The Health Effects Of Wood Smoke, Washington State Department Of Ecology). That is also why the exposure of pregnant mothers to wood smoke shrinks the white matter in the fetus' brain, and lowers its I.Q. proportionally to the exposure.[13]

Wood smoke are so laden with pollutants that are toxic to humans that power plants that burn forest residuals should not be incentivized to replicate or expand by awarding them carbon emissions credits.

The energy efficiency set aside should be doubled

Above, I have argued that the energy efficiency/demand reduction set aside in the proposed cap-and-trade program should be doubled, because the main substitute sources of electric power (coal and natural gas) are both such potent climate disruptors. The only substantial objection to making that adjustment to the program would be the fear that it would raise the price of electricity paid by the customer. The experience of RGGI in investing the proceeds of carbon credit auctions strongly implies that increasing the number of emissions credits that other sources of electricity must obtain would only serve to reduce the price that electricity customers pay, if the proceeds are distributed as they are in RGGI states.

Last month, RGGI issued a report concluding that more than $410 million in proceeds from its auctions in 2015 were invested in programs including energy efficiency, clean and renewable energy, greenhouse gas abatement, and direct bill assistance. The report concludes the 2015 investments are projected to provide participating households and businesses with $2.31 billion in energy bill savings, as well as avoiding the use of 9 million MWh of electricity and 28 million MMBtu of fossil fuel.
https://www.rggi.org/sites/default/files/Uploads/Proceeds/RGGI_Proceeds_Report_2015.pdf.

Of the $410 million invested, $232.4 was invested in energy efficiency programs, which are expected to yield $1.3 billion in energy bill savings over their 25-year useful lives, for an annual rate of return of over 7%. Of the $410 million, $65.6 was invested in renewable energy, which is

[12] Danielsen PH, Møller P, Jensen KA, Sharma AK, Wallin H, Bossi R, Autrup H, Mølhave L, Ravanat JL, Briedé JJ, de Kok TM, Loft S. Oxidative stress, DNA damage, and inflammation induced by ambient air and wood smoke particulate matter in human A549 and THP-1 cell lines. Chem Res Toxicol. 2011 Feb 18;24(2):168-84. Epub 2011 Jan 14; Karlsson HL, Ljungman AG, Lindbom J, Möller L: Comparison of genotoxic and inflammatory effects of particles generated by wood combustion, a road simulator and collected from street and subway. Toxicol Lett 2006, 165:203-211.

[13] Peterson B, et al. Effects of Prenatal Exposure to Air Pollutants (Polycyclic Aromatic Hydrocarbons) on the Development of Brain White Matter, Cognition, and Behavior in Later Childhood. JAMA Psychiatry. Published online March 25, 2015.doi:10.1001/jamapsychiatry.2015.57.

expected to yield energy bill savings of $785.8 over its 25-year useful life, for an annual rate of return of 10.5%. These rates of return are competitive with those achieved in the economy as a whole, before the social benefits of such investments are considered. For that reason, applying the proceeds of auctioned allowances to either energy efficiency or additional renewable capacity should increase the ability of such investments to lower overall electricity production costs.

IRENA's *Renewable Power Generation Costs in 2017* report, which was released on January 13, https://cms.irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017, says that the global levelized cost of utility-scale solar averaged $0.10 per kWh in 2017, and predicts that they will be half that by 2020. The report says that onshore wind and solar PV projects could be consistently delivering electricity for $0.03 per kWh by 2020, when Virginia's cap-and-trade plan would begin. This implies that doubling the set aside, whether the proceeds are used to increase the amount of low-cost renewable energy in the total energy mix, or to reduce demand for energy through energy efficiency programs, should drive the price of electricity for customers down, not up.